

Overview of the European Strategy in Research Infrastructures

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Abstract

The European Strategy Forum on Research Infrastructures (ESFRI) was established in 2002, with a mandate from the EU Council to support a coherent and strategy-led approach to policy-making on research infrastructures in Europe, and to facilitate multilateral initiatives leading to the better use and development of Research Infrastructures (RI), at EU and international level. ESFRI has recently presented its updated 2016 Roadmap which demonstrates the dynamism of the European scientific community and the commitment of Member States to develop new research infrastructures at the European level.

This work is focused on the identification of the new features and conclusions of the ESFRI Roadmap 2016 in terms of the methods and procedures that led to the call, the evaluation and selection of the new ESFRI Projects and the definition and assessment of the ESFRI Landmarks. An analysis of the impact of research infrastructures on structuring the European Research Area as well as the global research scene, and of the overall contribution to European competitiveness are also discussed focusing on data intensive RI and e-Infrastructures projects.

1 Introduction

ESFRI has recently fulfilled the commitment made by Member States and the European Commission in the Innovation Union flagship initiative and has implemented 60% of ESFRI projects by the end of 2015. The new ESFRI 2016 Roadmap demonstrates the dynamism of the European scientific community and the commitment of Member States to develop new research infrastructures at the European level. The networks of research infrastructures across Europe strengthen its human capital base by providing world-class training for a new generation of researchers and engineers and promoting interdisciplinary collaboration.

The objective of Horizon 2020 is to ensure the implementation and operation of the ESFRI and other

worldclass research infrastructures, including the development of regional partner facilities; integration of and access to national research infrastructures; and the development, deployment and operation of e-infrastructures. The major changes in Horizon 2020 with regard to the previous framework programme (FP7) include the emphasis on innovation and the development of human resources, addressing industry as an e-infrastructure supplier and user, more resolve towards service orientation and service integration, and more emphasis on data infrastructure development. In Horizon 2020 the e-infrastructure activities are part of the European Research Infrastructures, including e-infrastructures programme. The indicative budget for e-infrastructures from 2014 to 2020 is 890 million euros.

This work starts with an overview of the European strategy for RI, with a special emphasis in e-Infrastructures, as defined in the ESFRI Strategy report published in March 2016 and will then show that implementations of some of the facilities stipulated by the Strategy have already started under the H2020 support. Focus is given on the identification of the new features and conclusions of the ESFRI Roadmap 2016 in terms of the methods and procedures that led to the call, the evaluation and selection of the new ESFRI Projects and the definition and assessment of the ESFRI Landmarks. An analysis of the impact of research infrastructures on structuring the European Research Area as well as the global research scene, and of the overall contribution to European competitiveness will also follow. A further analysis of the ESFRI Projects and ESFRI Landmarks will also be provided focusing on RI and e-Infrastructure projects that are data-intensive. A Landscape Analysis will also be presented that provides the current context, in each domain, of the operational national and international research infrastructures open to European scientists and technology developers through peer-review of competitive science proposals. The e-infrastructures landscape, transversal to all domains, will be also elaborated as approached by the e-Infrastructure Reflection Group (e-IRG).

The work also focuses on recent initiatives and activities supporting the e-infrastructure activities in Horizon 2020 in order to achieve by 2020 a single and open European space for on-line research where researchers will enjoy leading-edge, ubiquitous and reliable services for networking and computing, and

seamless and open access to e-Science environments and global data resources, such as:

- The **European Open Science Cloud** initiative activities, towards facilitating integration in the area of European e-Infrastructures and connected services between the member states, at the European level, and internationally.
- Activities of the **e-Infrastructure Reflection Group (e-IRG)**, focusing on presenting the e-IRG Roadmap 2016 to be published this Summer 2016, which will give guidance and recommendations for policy and technical discussions on the main European Open Science Cloud topics.
- Activities involving **EU - Russian Federation** cooperation in the area of RI in FP7 and H2020.

Ultimately, the guidelines for providing access to RIs are given, and the impact of RIs to European Union and internationally are discussed.

2 European strategy for Research Infrastructures

Since 2006, ESFRI focuses on the identification of RIs in Europe across all scientific areas and periodically updates its roadmaps for providing a strategic vision for ensuring the access of RIs to researchers. Generally, the main objectives of ESFRI, as described in [5], are:

- to support a coherent and strategy-led approach to policy making on research infrastructures in Europe
- to facilitate multilateral initiatives leading to a better use and development of research infrastructures acting as an incubator for pan-European and global research infrastructures
- to establish a European Roadmap for research infrastructures (new and major upgrades, pan-European interest) for the coming 10-20 years, stimulate the implementation of these facilities, and update the Roadmap as the need arises
- to ensure the follow-up of implementation of already ongoing ESFRI projects after a comprehensive assessment, as well as the prioritization of the infrastructure projects listed in the ESFRI Roadmap

With the last roadmap, published in 2016, ESFRI has widened its horizon and scope by adopting a more focused, strategic approach and identifying a limited number of RIs with high added value for European research. The target is to fund a limited number of mature projects that will enhance European research and innovation competitiveness. Thus, as stated in [5], ESFRI added as an important eligibility condition that a proposal required a funding commitment from the submitting Member State or Associated Country along with a political commitment from at least two others. This requirement strengthened the transparency of the submission process and forced a dialogue and crosscheck

between the research communities and the concerned governments from the very beginning of the RI project

[5]. This is also ensured by performing a landscape analysis of RIs for identifying their strengths, potential and weaknesses in all fields of research.

2.1 Landscape Analysis and ESFRI Landmarks

The purpose of landscape analysis is to identify the operating open access RIs from national, regional and international infrastructures, as well as groups that provide integrated solutions with open access to the state-of-the-art resources. The impact of the landscape analysis by the ESFRI infrastructures is emphasised by the list of ESFRI Landmarks, that are implemented ESFRI projects (or started implementation under the roadmap) with great success on providing scientific services and competitiveness of the European Research Area.

The key elements of the new ESFRI process, as stated in [5], are:

- definition of clear rules, communication and explanation of the procedure at the start;
- delineation of a window of opportunity: new projects will remain on ESFRI Roadmap for a maximum of ten years;
- evaluation of scientific relevance and project maturity in parallel but separately;
- engagement of international experts and peer reviewers in the evaluation process;
- adoption of a lifecycle approach to the analysis of infrastructures, with *Projects* and *Landmarks* clearly identified and indication of *emerging opportunities*;
- assessment of the implementation of the inherited projects from Roadmap 2008 and 2010 for monitoring their progress and identifying areas where support is needed;
- recognition and analysis of the overall “Landscape” of the European research infrastructure system and of the complementarity of projects;
- identification of the role of the successful ESFRI infrastructures and definition of the “Landmark list”;
- monitoring of Projects and periodic review of Landmarks, and update of the Roadmap.

Emphasis on new ESFRI projects is always given on excellence, impact, sustainability and continuous report.

2.2 The ESFRI Roadmap 2016 projects and Landmarks

The new ESFRI roadmap contains 21 ESFRI projects, 9 from the 2008 roadmap, 6 from the 2010 roadmap and five new project (plus one reoriented project). The evaluation process for selecting the new projects was a) the Strategy Working Groups with respect to their scientific excellence, pan-European relevance and socio-economic impact and b) their degree of maturity as benchmarked by the ESFRI Implementation Group.

Table 1 The ESFRI projects, [5].

Domain	Name	Full Name	Roadmap entry	Operation	Construction cost	Operational annual budget (M€YEAR)
ENERGY	ECCSEL	European Carbon Dioxide Capture and Storage Laboratory Infrastructure	2008	2016	80-120	1
	EU-SOLARIS	European SOLAR Research Infrastructure for Concentrated Solar Power	2010	2020	120	3-4
	MYRRHA	Multi-purpose hYbrid Reactor for High-tech Applications	2010	2024	N/A	100
	WindScanner	European WindScanner Facility	2010	2018	45-60	8
ENVIRONMENT	ACTRIS	Aerosols, Clouds and Trace gases Research Infrastructure	2016	2025	190	50
	DANUBIUS-RI	International Centre for Advanced Studies on River-Sea Systems	2016	2022	222	28
	EISCAT_3D	Next generation European incoherent scatter radar system	2008	2021	74	6
	EPOS	European Plate Observing System	2008	2020	53	15
	SIOS	Svalbard Integrated Arctic Earth Observing System	2008	2020	80	2-3
HEALTH & FOOD	AnaEE	Infrastructure for Analysis and Experimentation on Ecosystems	2010	2018	200	2-3
	EMBRC	European Marine Biological Resource Centre	2008	2016	4.5	6
	EMPHASIS	European Infrastructure for multi-scale Plant Phenomics and Simulation for food security in a changing climate	2016	2020	73	3.6
	ERINHA	European research infrastructure on highly pathogenic agents	2008	2018	N/A	N/A
	EU-OPENSCREEN	European Infrastructure of Open Screening Platforms for Chemical Biology	2008	2018	7	1.2
	Euro-BioImaging	European Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences	2008	2017	N/A	1.55
	ISBE	Infrastructure for Systems Biology Europe	2010	2018	30	7.2
	MIRRI	Microbial Resource Research Infrastructure	2010	2019	6.2	1
PHYSICAL SCIENCES & ENGINEERING	CTA	Cherenkov Telescope Array	2008	2023	297	20
	EST	European Solar Telescope	2016	2026	200	9
	KM3NeT 2.0	KM3 Neutrino Telescope 2.0: Astroparticle & Oscillations Research with Cosmics in the Abyss	2016	2020	92	3
SOCIAL & CULTURAL INNOVATION	E-RIHS	European Research Infrastructure for Heritage Science	2016	2022	4	5

Regarding the ESFRI Landmarks, 29 are listed containing already implemented projects and two new projects that were evaluated and are under construction. The list of the ESFRI projects (Table 1) and the ESFRI Landmarks (Table 2) are presented in [5], and are categorized in the following application categories:

- Energy (4 projects)
- Environment (5 projects)
- Health & Food (8 projects)
- Physical Sciences & Engineering (3 projects)
- Social & Cultural Innovation (1 project).

2.3 Big Data in Research Infrastructures

Data occurring from RIs by experimentation, measurements, observations, data analysis, modelling and simulations are usually large or complex that

traditional data processing applications are insufficient to process. Moreover, the analysis of such data is crucial to scientific research and usually require high performance computing or cloud computing capabilities in order to process them.

For this reason, the Research Data Alliance (RDA) addresses a global data policy with direct connections with e-IRG, with specific actions on standardization strategies, like PanData for analytic facilities [7]. Usually, such data occur from physics experiments, astronomical research, biomedical interests or large scale simulations of complex systems. The distributed nature of RIs in the domains listed before, enhances the need for effective data access and analysis. Thus, the ESFRI is expected to play a significant role in this general development, by formulating a new generation of big data practitioners and big data engineers.

Table 2 The ESFRI Landmarks, [5].

Domain	Name	Full Name	Roadmap entry	Operation	Capital Value (M€)	Operational annual budget (M€YEAR)
ENERGY	JHR	Jules Horowitz Reactor	2006	2020	1000	N/A
ENVIRONMENT	EMSO	European Multidisciplinary Seafloor and water-column Observatory	2006	2016	108	36
	EURO-ARGO ERIC	European contribution to the international Argo Programme	2006	2014	10	8
	IAGOS	In-service Aircraft for a Global Observing System	2006	2014	25	6
	ICOS ERIC	Integrated Carbon Observation System	2006	2016	48	24-35
	LifeWatch	e-infrastructure for Biodiversity and Ecosystem Research	2006	2016	66	10
HEALTH & FOOD	BBMRI ERIC	Biobanking and BioMolecular resources Research Infrastructure	2006	2014	170-220	3.5
	EATRIS ERIC	European Advanced Translational Research Infrastructure in Medicine	2006	2013	500	2.5
	ECRIN ERIC	European Clinical Research Infrastructure Network	2006	2014	1.5	2
	ELIXIR	A distributed infrastructure for life-science information	2006	2014	125	95
	INFRAFRONTIER	European Research Infrastructure for the generation, phenotyping, archiving and distribution of mouse disease models	2006	2013	180	80
	INSTRUCT	Integrated Structural Biology Infrastructure	2006	2012	285	25
PHYSICAL SCIENCES & ENGINEERING	E-ELT	European Extremely Large Telescope	2006	2024	1000	40
	ELI	Extreme Light Infrastructure	2006	2018	850	90
	EMFL	European Magnetic Field Laboratory	2008	2014	170	20
	ESRF UPGRADES	Phase I Phase II: Extremely Brilliant Source	2006 2016	2015 2022	180 150	82
	European Spallation Source ERIC	European Spallation Source	2006	2025	1843	140
	European XFEL	European X-Ray Free-Electron Laser Facility	2006	2017	1490	115
	FAIR	Facility for Antiproton and Ion Research	2006	2022	1262	234
	HL-LHC	High-Luminosity Large Hadron Collider	2016	2026	1370	100
	ILL 20/20	Institut Max von Laue-Paul Langevin	2006	2020	171	92
	SKA	Square Kilometre Array	2006	2020	650	75
SOCIAL & CULTURAL INNOVATION	SPIRAL2	Système de Production d'Ions Radioactifs en Ligne de 2e génération	2006	2016	110	5-6
	CESSDA	Consortium of European Social Science Data Archives	2006	2013	N/A	1.9
	CLARIN ERIC	Common Language Resources and Technology Infrastructure	2006	2012	N/A	12
	DARIAH ERIC	Digital Research Infrastructure for the Arts and Humanities	2006	2019	4.3	0.6
	ESS ERIC	European Social Survey	2006	2013	N/A	6
e-RI	SHARE ERIC	Survey of Health, Ageing and Retirement in Europe	2006	2011	110	12
	PRACE	Partnership for Advanced Computing in Europe	2006	2010	500	120

3 ESFRI Evaluation Process

The evaluation process of new projects from ESFRI adopted a transparent approach together with national research authorities and research communities of the new roadmap process. This process is illustrated in Figure 1, and consists of five distinct steps, as presented in [5]:

- *Review of projects from previous ESFRI roadmaps.* The RIs that were implemented and produced high quality services to the community led to the identification of the ESFRI Landmarks. The lifecycle analysis performed for the identification of scientific key services is now adopted and key issues can now be resolved for the remaining projects.
- *Submission and eligibility of proposals.* Members or Associated countries can submit proposals to the ESFRI Roadmap 2016. New ESFRI Projects have to be competitive and mature, while the ability to be implemented within ten years is crucial. They need to demonstrate government level financial commitment of the proponent Member State or Associated Country plus at least two additional political commitments. This increases the likelihood of success for the projects and enables a more robust and reliable selection process by ESFRI.
- *Evaluation of proposals.* Eligible proposals were assessed through two parallel and independent evaluation processes. The Strategy Working Groups (SWGs) evaluated the scientific case, i.e. scientific merit, relevance and impact, European added value, socio-economic benefit and the needs of interfacing or integrating external e-infrastructure. The SWG identified assigns a minimum of three independent international peer-reviewers who contribute their evaluation on the science aspects of the project. In parallel, the Implementation Group (IG) assessed the maturity, i.e. stakeholder commitment, user strategy and access policy, preparatory work, planning, governance and management, human resources policy, finances, feasibility and risks. The IG similarly assigns international expert evaluators to assess the relevant “maturity” aspects of each project. Based on their own analysis and on the reports from the referees, the SWG and IG identified critical questions and issues to be addressed by each of the eligible proposals. The SWG and IG subsequently reached their conclusions with a joint recommendation per project, and an overall harmonization to align the results from the different areas and formulate a ranking of the projects and recommendations.
- *Decision making.* The executive board proposes a final recommendation on the list of projects

and Landmarks that should be included for a final decision.

4 e-infrastructure activities in Horizon 2020

During the last decades, scientific applications require challenging demands of interoperable data, computational power and collaborations between different scientific fields and researchers. The developed large scale information systems called e-infrastructures and are supported by many initiatives in Europe and worldwide.

The European Commission (EC) is interested on investing through its Framework Programmes in e-Infrastructures since they are considered as key enablers of the European Research Area (ERA). The collaboration among scientific communities of researchers that work together on complex multi-disciplinary problems whose solutions are highly beneficial for the society and the progress at large are then of high importance, [1].

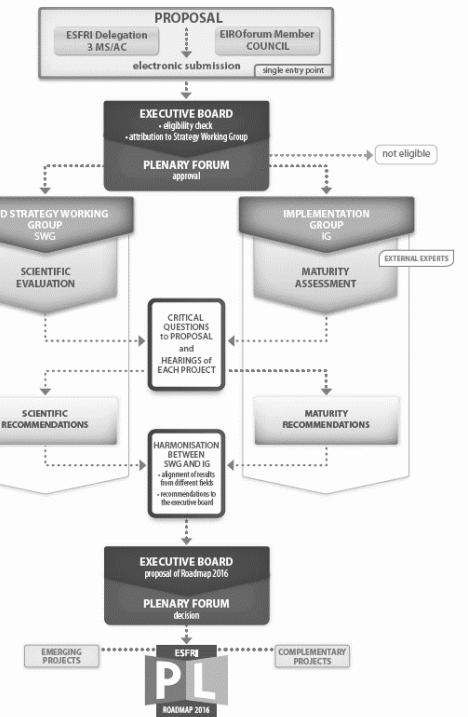


Figure 1 The ESFRI evaluation process of new projects, [5].

The corresponding H2020 call for e-infrastructures (H2020-EINFRA-2016-2017) focuses on the open research data, data and computing intensive science, research and education networking, high performance computing and big data innovation. The following principles are key elements for the project implementations:

- *Service orientation:* The funded projects will contribute to the formulation of a high quality catalogue of services describing the services that they will provide during the lifetime of the projects. A service oriented European e-infrastructure landscape will be supported by

adopting new knowledge and innovative ICT solutions by global and multidisciplinary research.

- *Maximizing and assessing the impact of the e-infrastructures:* Projects should have a clear plan for active participation in international fora and research groups/initiatives to promote data and computing infrastructure interoperability.
- *Co-Design:* A balanced set of partners with complementary competences and roles should form the consortium of projects that will be funded by this call.
- *Open Research Data:* In order to make research data discoverable, accessible, intelligible, useable and interoperable, this call focuses on open data taking into account the above criteria.
- *H2020 as a catalyst of the European plan for growth and jobs:* This call will promote the use of other funding sources as instrument to support initiatives of European interest to foster growth and jobs.

The call has two themes: “*Integration and consolidation of e-infrastructure platforms supporting European policies and research and education communities*” and “*Support to the next implementation phase of Pan-European High Performance Computing infrastructure and services (PRACE)*” with several topics. More details and the specific topics can be found in [2].

Recent initiatives and activities for supporting the e-infrastructure activities in Horizon 2020 have been formulated. In order to achieve by 2020 a single and open European space for on-line research where researchers will enjoy leading-edge, ubiquitous and reliable services for networking and computing, and seamless and open access to e-Science environments and global data resources, several research groups and cooperation have been instantiated. The distribution of Research Infrastructures in Europe is illustrated in Figure 2.

4.1 European Open Science Cloud

Recently, the Commission High Level Expert Group on the European Open Science Cloud (HLEG EOSC) has drafted a first report on the realization of the European Open Science Cloud that will be published after summer 2016. With this initiative, EOSC aims to introduce, accelerate and support the Open Science and Open Innovation in the Digital Single Market, thus enabling re-use of geographically distributed scientific data.

EOSC is a European infrastructure, worldwide accessible and interoperable, including all the required human expertise, resources, standards, best practices and the underlying technical infrastructures. Special emphasis is given on the support of the Finding, Access, Interoperation and the re-use of open and sensitive secured data. It supports also data related elements, i.e. software, standards, protocols and workflows, that allow the data driven knowledge discovery and innovation.



Figure 2 Research Infrastructures funded by the European Commission¹.

Due to the fact that about 50% of the research data are not reproducible, EOSC aims to realize the ambition of collaboration across research infrastructures through re-use of scientific data across Europe.

4.2 e-Infrastructure Reflection Group (e-IRG)

The e-Infrastructure Reflection Group (e-IRG), founded in 2003, is a European independent body with mission to form a general purpose European e-Infrastructure by providing guidance on the development of a European e-Infrastructure for science and research. Some examples of already established e-Infrastructures across Europe are GEANT (networking - <http://www.geant.org/>), EGI (cloud computing - <https://www.egi.eu/>), PRACE (supercomputing - <http://www.prace-ri.eu/>), EUDAT (big data - <https://www.eudat.eu/>), IDGF (crowd computing - <http://idgf-sp.eu/>), OpenAire (repository for scientific articles - <https://www.openaire.eu/>).

e-IRG initiative purpose is to support strategic European e-Infrastructure policymaking and the development of convergent and sustainable e-Infrastructure services. As stated in the revised Mission and Vision statement of e-IRG, [6], the two main objectives are “*Sustain e-IRG as the leading European advisory body on e-Infrastructures*” and “*Maintain and further develop e-IRG in its role as the facilitator and stimulator of European e-infrastructure collaboration*”.

To reach these goals, e-IRG acts as advisory body by producing strategic and policy reports, analyses and recommendations. e-IRG has also the ambition to influence regional and European policy makers and to promote scientific excellence approach in e-Infrastructure policy making. After the publication of the ESFRI Roadmap 2016, the e-IRG group is intended to publish the e-IRG Roadmap 2016 during the summer of 2016, which will provide guidance and recommendations for policy and technical discussions on the main European Open Science Cloud topics.

4.3 EU-Russian Federation cooperation in H2020

The support of Russian Federation in European research projects, and more specifically in Horizon 2020 actions,

¹ http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=mapri

is established by the Ministry of Education and Science of the Russian Federation. Dedicated calls offer co-funding support for Russian Horizon 2020 participants in accordance with the Russian Federal Programme (FTP) “R&D in Priority Areas of Development of the Russian S&T Complex 2014-2020” managed by the Russian Ministry of Education & Science (MES).

In 2014, the European Commission published the Roadmap for international cooperation document, [4], including the Russian Federation, as report on the implementation of the strategy for international cooperation in research and innovation. Specific opportunities of collaboration offered 13 thematic working groups: aeronautics, energy, environment and climate change, food, agriculture, biotechnology, health, ICT research, e-infrastructures, mobility, nanotechnology/materials, research infrastructures, and space.

5 Access to Research Infrastructures

European Commission, in close cooperation with the ESFRI, the e-IRG group and other EU organizations developed the Charter for Access to Research Infrastructures, for promoting the harmonisation of access procedures and enhanced transparency of access policies in order to enable the remote access of users to the RIs. This document was published in March 2016, [2], and it is accompanied with reference documentation containing complementary material regarding the definition of an access policy for any RI.

The charter promotes access to RIs and interaction with a wide range of social and economic activities, including business, industry and public services, in order to maximise the return on investment in RIs and to drive innovation, competitiveness and efficiency, [2]. The Charter for Access to RIs proposes the following guidelines that each RI have to specify, [2]:

- *Access policy:* The Access Policy should define the access in terms of Access Units, the state of the specific Access mode, clarify the conditions for Access, describe the processes and interactions involved in the Access and elaborate on the support measures facilitating the Access.
- *Access modes:* Three different Access modes have been defined, i.e. excellence-driven, market-driven and wide. Thus, each access to a RI may be regulated according to one Access mode or any combination of them.
- *Access restrictions:* Definition of possible restrictions by means of quota or pre-defined user groups.
- *Access processes and interactions:* The following processes and interactions are defined in the Access to RIs: application, negotiation, evaluation, feedback, selection, admission, approval, feasibility check, setting-up, use,

monitoring and dismantling.

- *Support measures facilitating Access:* RIs are encouraged to offer support measures such as guidance through user manuals, provision of user support, provision of accommodation and guidance with immigration procedures.
- *Education and training:* RIs are encouraged to offer education and training, as well as to collaborate with other institutions and organizations that benefit from using RIs for their education and training purposes.
- *Regulatory framework:* A regulatory framework should be defined when providing access to a RI, that should cover Access, intellectual property rights, data protection, confidentiality, liability and possible fees.
- *Transparency:* Each RI should provide transparent information on the RI itself, including its services, access policy, data management policy and the terms and conditions.
- *Research data management plan:* RIs and users should have an agreement on a data management plan outlining how the research data will be handled.
- *Health, safety, security and environment:* RIs should take the necessary actions to ensure the health, security and safety of any user accessing the RI itself, as well as to minimize the impact on the environment.
- *Quality assurance:* RIs are encouraged to set up mechanisms in order to evaluate the quality of the provided access to users.
- *Limitations:* Access to RIs may be limited by the following: national security and defence; privacy and confidentiality; commercial sensitivity and intellectual property rights; ethical considerations in accordance with applicable laws and regulations.

Therefore, all the established RIs have published² in accordance with the charter, their individual access policies to foster collaboration among researchers across Europe. International cooperation and access to RIs is strongly encouraged from the European Commission, thus RIs should also define how non-EU members can gain access to their infrastructures.

6 Impact of Research Infrastructures

The relationship between academia and RIs contributes to an effective European educational and scientific ecosystem that attracts and supports industry. The optimal distribution of the RIs across Europe (Figure 2), is of great importance since it contributes in promoting European cohesion, [5]. The knowledge-based economy is effectively stimulated by strengthening the links between RIs, higher education and research institutions with economic players like industry, services and

²https://ec.europa.eu/research/infrastructures/index_en.cfm?pg=charte_r_access_ri

utilities, [5].

The ESFRI Working Group on Innovation (WG INNO) promoted the industrial capabilities of the RIs on the ESFRI Roadmap in order to push the cooperation of pan-European RIs with industry. This implies promoting partnerships on R&D projects for realizing ecosystems of integrated competences, services and technologies facilitating industrial innovation. Generally, linking the RIs among themselves and allowing the broader social, technological and economical players to acquire information from multiple resources in an effective, efficient and sustainable way, [5].

The success of many RIs lead the G8+5 Group of Senior Officials (GSO) to define a strategy for Global Research Infrastructures (GRI). A well-known example of a GRI is CERN for high-energy physics that is now considered as a globalized infrastructure. The Global Science Forum is responsible for identifying GRI needs and opportunities, including the organizational and long term sustainability aspects. ESFRI acts as a reliable partner at the global level in the practical development of scientific and political initiatives aimed at internationalization of new or existing infrastructures that appear ready to move to a global operation involving access, data policy, and lifecycle management and to consider international governance, [5].

7 Conclusions

European Commission and the ESFRI group have provided the resources and competence for supporting a strong research and innovation profile for their members, by sharing expensive scientific equipment and e-infrastructures, capitalising on cross-border collaboration and human potential across Europe. The main principles for the European strategy for Research Infrastructures rely on the adoption of a coherent participation model in European and global RI initiatives, utilization of a continuous collaboration among academia and industry, and on the harmonization of investment in e-infrastructures, as key enablers of a knowledge intensive economy, for and of eScience. A coordinated policy framework of e-Infrastructures, including fast networking, storage, high performance computing, data access and management structures and services has been progressing during the last years.

ESFRI, over the past decade, has improved the efficiency and impact of the European RIs, that are moving towards a sustainable investment for overall

competitiveness. With the new published ESFRI Roadmap 2016, new methods and procedures have been adopted, as well as new procedures for the evaluation and selection of new projects and definition and assessment of the ESFRI Landmarks. Enhancing and optimising RIs and their access by scientists and researchers is a key element of competitiveness as well as a necessary basis for dealing with societal challenges.

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